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MEMORANDUM OF AGREEMENT

ON

OPERATIONAL SUITABILITY TERMINOLOGY AND DEFINITIONS

TO BE USED IN

OPERATIONAL TEST AND EVALUATION (OT&E)

JUNE 2002

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1. PURPOSE. This Memorandum of Agreement (MOA) provides the policy and suitability terminology and definitions to be used by the Service Operational Test Agencies (OTAs) for the quantitative portion of suitability evaluations.

2. BACKGROUND. Formerly, Annex A to the MOA on MOT&E contained common reliability, availability and maintainability (RAM) terms to be used by all OTAs in the conduct of Joint or Multiservice OT&E. The OTA commanders initiated an effort to standardize suitability terms across all OT&E. This MOA is the result of that effort. The terms and definitions in this MOA are intended to convey the same meaning to all Services. Therefore, they attempt to avoid terms used elsewhere with different meanings. Existing terms used by one or more Services were selected when possible.

3. REFERENCES:

a. Joint Publication 1-02, 23 March 1994, The DoD Dictionary of Military and Associated Terms.

b. The Defense Acquisition Deskbook Glossary.

c. Operational Suitability Guide, Volume I, February 1990 (published by the Office of the Director of Operational Test and Evaluation).

4. POLICY

a. The terms described in this MOA will be used as appropriate in all OT&E. If additional terms are necessary, they must be clearly defined in OT&E Plans.

b. Applicable terms selected from this MOA will be included in the system Test and Evaluation Master Plan. As this requirement involves agreement by the program office and system user, an implementation period of two years is anticipated. This period of time is necessary for the acquisition and using communities of each Service to review this MOA, incorporate any changes, and revise Service operating instructions.

c. Measurement of the terms described in this memorandum may vary between types of system (aircraft, space, ships, vehicles, etc.). This is due to differences among a system's operating characteristics (continuous operation, intermittent operation, non-operating, etc.), part of the system under test (end item, segment, subsystem, etc.), design requirements (redundancy, non-redundancy), system maintenance policies, mission requirements, and reliability incident classifications (mission failures, system failures, unscheduled maintenance, etc.). As such, specific measures associated with each term will be clearly defined in the test plan and other appropriate test documentation.

5. BASIC OPERATIONAL SUITABILITY TERMINOLOGY. Operational suitability is defined as "the degree to which a system can be placed satisfactorily in field use with consideration given to availability, compatibility, transportability, interoperability, reliability, wartime usage rates, maintainability, safety, human factors, manpower supportability, logistics

supportability, natural environmental effects and impacts, documentation, and training requirements." [The Defense Acquisition Deskbook Glossary.] The following defines those basic suitability terms and definitions to be used by the OTAs:

a. Availability. A measure of the degree to which an item is in the operable and committable state at the start of a mission when the mission is called for at an unknown (random) time. [The Defense Acquisition Deskbook Glossary.]

b. Compatibility. Capability of two or more items or components of equipment or material to exist or function in the same system or environment without mutual interference. [Joint Pub 1-02.] Compatibility may apply to a specific investigation of a system's electrical, electromagnetic, physical, and man-machine interface characteristics. Because of such applications, compatibility may also be addressed as part of the operational effectiveness evaluation in OTA test plans and reports.

c. Transportability. The capability of materiel to be moved by towing, self-propulsion or carrier via any means, such as railways, highways, waterways, pipelines, oceans, and airways. [Joint Pub 1-02.] (Full consideration of available and projected transportation assets, mobility plans and schedules and the impact of system equipment and support items on the strategic mobility of operating military forces is required to achieve this capability.)

d. Interoperability. The ability of systems, units, or forces to provide services to and accept services from other systems, units, or forces and to use the services so exchanged to enable them to operate effectively together. [The Defense Acquisition Deskbook Glossary and Joint Pub 1-02.] Interoperability is often addressed as part of the operational effectiveness evaluation in OTA test plans and reports.

e. Reliability. The ability of an item to perform a required function under stated conditions for a specified period of time.

f. Usage Rates

(1) Wartime Usage Rates. The quantitative statement of the projected manner in which the system is to be used in its intended wartime environment. [Operational Suitability Guide, Vol 1.]

(2) Peacetime Usage Rates. The quantitative statement of the projected manner in which the system is to be used in its intended peacetime environment.

g. Maintainability. The ability of an item to be retained in or restored to specified condition when maintenance is performed by personnel having specified skill levels, using prescribed procedures and resources, at each prescribed level of maintenance and repair. [The Defense Acquisition Deskbook Glossary.]

h. Safety. Freedom from conditions that can cause death, injury, occupational illness, damage to or loss of equipment or property, or damage to the environment. [Operational Suitability Guide, Vol 1.]

i. Human Factors. The systematic application of relevant information about human abilities, characteristics, behavior, motivation, and performance. It includes principles and applications in the areas of human engineering, anthropometrics, personnel selection, training, life support, job performance aids, and human performance evaluation. [The Defense Acquisition Deskbook Glossary.] Within the context of this definition, human factors also may be addressed as part of the operational effectiveness evaluation in OTA test plans and reports.

j. Manpower Supportability. The identification and acquisition of military and civilian personnel with the skills and grades required to operate and support a material system over its lifetime at peacetime and wartime rates. [Operational Suitability Guide, Vol 1.]

k. Logistics Supportability. The degree to which planned logistics support (including test, measurement, and diagnostic equipment; spares and repair parts; technical data; support facilities; transportation requirements; training; manpower; and software support) allow meeting system availability and wartime usage requirements.

l. Natural Environmental Effects and Impacts

(1) Environment. Used as a general reference, environment includes the generic natural environment; e.g., weather, climate, ocean conditions, terrain, vegetation, etc. Environment includes those conditions observed by the system during operational use, stand-by, maintenance, transportation, and storage.

(2) Environmental Effects. The effects of the natural environment on the system. For example, corrosion is a natural environmental effect caused by weather, ocean conditions, etc.

(3) Environmental Impacts. The system's impact on the natural environment as a result of its operational use, maintenance, transportation, and storage. For example, impacts include pollution (noise, air, and water), threat to endangered species, threat to public health, etc.

m. Documentation. Comprise operator and maintenance instructions, repair parts lists, and support manuals, as well as manuals related to computer programs and system software. [Operational Suitability Guide, Vol 1.]

n. Training Requirements. The processes, procedures, techniques, training devices, and equipment used to train civilian and active duty and reserve military personnel to operate and support a materiel system. This includes individual and crew training; new equipment training; initial, formal, and on-the-job training; and logistics support planning for training equipment and training device acquisitions and installations. [Operational Suitability Guide, Vol 1.]

6. OTHER SUITABILITY TERMINOLOGY. Suitability considerations defined above may be aggregated to give a higher level determination of the system's capability to be placed in field use. When doing so, other terminology related to suitability is used. These other terms are:

a. Readiness. The probability that, at any point in time, a system or equipment is either operating satisfactorily or ready to be placed in operation on demand when used under stated conditions, including stated allowable warning time.

b. Sustainability:

(1) Wartime Sustainability. The ability to maintain the necessary level and duration of operational activity to achieve military objectives. Sustainability is a function of providing for and maintaining those levels of ready forces, materiel, and consumables necessary to support military effort.

(2) Peacetime Sustainability. The ability to maintain the necessary levels of forces, materiel, and consumables to support the burden of ownership of the system.

c. Diagnostics. The ability of integrated diagnostics (automated, semi-automated, and manual techniques taken as a whole) to fault-detect and fault-isolate in a timely manner.

7. COMMON RAM MEASURES. The purpose of this list of measures is to standardize terminology, not tests. It is not mandatory to design tests, collect data, or calculate a measure, just because it is listed below. However, if the measure is calculated, use the common term in test planning and documentation. Relevant, service-unique RAM measures are provided in appendices to this MOA.

a. Reliability. Reliability consists of two major areas: mission reliability and logistics support frequency.

(1) Mission Reliability. A measure of the ability of an item to perform its required mission critical functions for the duration of a specified mission. [The Defense Acquisition Deskbook Glossary.] Mission reliability can also be stated as the probability a system can complete its required operational mission without an operational mission failure (OMF). An OMF is a failure that prevents the system from performing one or more mission essential functions. For some systems, mission reliability may be better expressed as a function of Mean Time (miles, rounds, etc.) Between Operational Mission Failure (MTBOMF). (See paragraph 8 for definition.) An additional related mission reliability parameter is Mean Time Between System Abort (MTBSA) (explained in Appendix 1.)

(2) Logistics (Maintenance/Supply) Related Reliability. A measure of reliability that addresses all incidents that requires a response from the logistics system. This term is subdivided into maintenance-related reliability and supply-related reliability. Logistics Related Reliability is the probability that no corrective (or unscheduled) maintenance, unscheduled removals, and/or unscheduled demands for spare parts will occur following the completion of a specific mission profile. Logistics Related Reliability may be expressed as a function of Mean Time Between Unscheduled Maintenance (MTBUM). (See paragraph 8 for definition.)

b. Maintainability. Maintainability consists of three major areas: time to repair OMFs, total corrective maintenance time, and maintenance burden or maintenance ratio. Maintainability may

be expressed as (1) Mean Corrective Maintenance Time for Operational Mission Failure Repairs (MCMTOMF), (2) Mean Corrective Maintenance Time for all incidents (MCMT), (3) Maximum (e.g., 90 Percentile Time) Corrective Maintenance Time for Operational Mission Failures (MaxCMTOMF), (4) Maximum (e.g., 90 Percentile) Corrective Maintenance Time for all incidents (MaxCMT), and (5) various maintenance ratios (MR), e.g., Maintenance Man-Hours Per Operating Hour, Mile, Round, etc. (See paragraph 8 for definitions.)

c. Availability. When conducting OT&E, Availability is normally expressed as Operational Availability (Ao) which is a measure of the probability that a system will be operating or capable of operation when required. (See paragraph 8 for definition.)

d. Diagnostics. Diagnostics may be expressed as (1) a measure of false alarms (number, percent, probability, rate, etc.) (2) the percent of correct detection given that a fault has occurred (Pcd), (3) the percent of correct fault isolation (and/or fault location) given a correct detection (Pcfi and/or Pcfl), and (4) Mean Time To Fault Locate (MTTFL). (See paragraph 8 for definitions.)

8. COMMON RAM DEFINITIONS

a. Mean Time Between Operational Mission Failures (MTBOMF): The total operating time (e.g., driving time, flying time, or system-on time) divided by the total number of OMFs.

b. Mean Time Between Unscheduled Maintenance (MTBUM): The total operating time divided by the total number of incidents requiring unscheduled maintenance.

c. Mean Corrective Maintenance Time for Operational Mission Failures (MCMTOMF): The total number of clock-hours of corrective, on-system, active repair time, which was used to restore failed systems to mission-capability status after an operational mission failure (OMF) occurs, divided by the total number of OMFs.

d. Mean Corrective Maintenance Time (MCMT): The total number of clock-hours of corrective, on-system, active repair time due to all corrective maintenance divided by the total number of incidents requiring corrective maintenance.

e. Maximum Corrective Maintenance Time for Operational Mission Failures (MaxCMTOMF): That time below which a specified percentage of corrective maintenance tasks must be completed to restore the system to operation after an Operational Mission Failure.

f. Maximum Corrective Maintenance Time (MaxCMT): That time below which a specified percentage of all corrective maintenance tasks must be completed.

g. Maintenance Ratio (MR): The most common expression for Maintenance Ratio (MR), is Maintenance Man-hours per Operating Hour, which is an indication of the maintenance burden associated with the system. The cumulative number of maintenance man-hours during a given period divided by the cumulative number of operating hours. If appropriate, other terms such as miles or rounds may be substituted for hours. Scheduled as well as corrective maintenance, in

keeping with the users maintenance requirements, are included without regard to their effect on mission or availability of the system.

h. Operational Availability (Ao): Ao is either the total uptime divided by the total calendar time (uptime plus downtime) for continuous operating systems, or the number of systems that are ready, divided by the number possessed (e.g., the number of times the system was available, divided by the number of times the system was required) for on-demand systems.

i. Measures of False Alarms (FA): False alarms are faults, where, upon investigation, it is found the fault cannot be confirmed. Measures of FA may be expressed as a total number, a percentage, a rate of occurrence, a probability of occurrence, etc. The selected measure must be clearly stated.

j. Percent of Correct Detection given that a fault has occurred (Pcd): The number of correct detections divided by the total number of confirmed faults times 100 (to express the quotient as a percent.)

k. Percent of Correct Fault Isolation (and Correct Fault Location) given correct detection (Pcfi): The number of correct fault isolations (and/or correct fault locations) divided by the number of correct detections times 100 (to express the quotient as a percent). "Fault isolation" and/or "fault location" must be clearly defined.

l. Mean Time To Fault Locate (MTTFL): The total amount of time required to locate faults divided by the total number of faults.

9. QUADRI-SERVICE REVIEW

a. Responsibility for issuing a call for a review of this MOA will be rotated among the Services. This call will be initiated at least 30 days prior to the anniversary date of the MOA. That Service also has the responsibility for calling such meetings as are required to reach agreement on proposed changes/additions to this MOA, and will take the lead in publishing change pages or republishing the entire document.

b. Terms of this agreement become effective upon signature by all parties and may be revised by mutual consent provided such changes are accomplished by written agreement.

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APPENDIX 1

ARMY TERMS AND DEFINITIONS

1. PURPOSE. This Appendix provides the RAM terms and definitions used most often within the Army in accordance with HQ TRADOC Guidelines for Developing Failure Definition & Scoring Criteria, and TRADOC/AMC PAMPHLET 70-11. It also includes some terms that have recently been used in new requirements documents but have not been documented in Army Regulations or Pamphlets. This information is included in this Annex to assist other services in understanding RAM terms that may be used by the Army in addition to the common terms provided in Paragraph 8 of this Annex.

2. DEFINITIONS:

a. Crew Correctable Maintenance Demand (CCMD). CCMDs result from failures corrected by the systems crew within guidelines determined by the combat developer, taking into account the impact on system performance and mission accomplishment.

b. Durability. A special case of reliability; the probability that an item will successfully survive to its projected life, overhaul point, or rebuild point (whichever is the more appropriate durability measure for the item) without a durability failure. (See Durability Failure.)

c. Essential Function Failure (EFF). Any incident or malfunction of the system that causes (or could have caused) the loss of one or more essential functions or degradations of an EF below specified levels. An EFF prevents the system from being fully mission capable (FMC) under wartime definitions. EFFs of such degree that cause the system to be not mission capable (NMC) are also defined as System Aborts (SA).

d. Essential Logistics Demand (ELD). A measure of the impact on supply channels which meets the DoD guidance for a logistics reliability parameter. ELDs include all EUMDs that require parts or line-replaceable units (LRU) and all scheduled maintenance demands that require parts or LRUs. ELDs also include crew correctable maintenance demands (CCMD) that use parts from the Basic Issue Item (BII). This category does not include operator or crew level preventive maintenance checks and services (PMCS), it may include items/parts consumed during the conduct of PMCS.

e. Essential Unscheduled Maintenance Demand (EUMD). An unscheduled maintenance event resulting from an essential function failure or system abort. Fully redundant component failures, albeit do not cause the loss of a mission essential function due to redundancy, should be classified in this category since they are necessary for the system to be fully capable. An EFF that is corrected by the crew/operator (and authorized in the TM or other applicable document), generates both an EUMD and a CCMD.

f. Failure. The event, or inoperable state, in which an item or part of an item does not, or would not, perform as previously specified. (See MIL-STD-721.)

g. Failure, Durability. A malfunction that precludes further operation of the item, and is great enough in cost, safety, or time to restore, that the item must be replaced or rebuilt.

h. Failure Mode. The mechanism through which failure occurs in a specified component (for example, fatigue, fracture, or excessive wear). (See MIL-STD-721.)

i. Inherent RAM Value. Amy measure of RAM that includes only the effects of an item design and its application and assumes an ideal operating and support environment.

j. Logistics Demand (LD). A measure of the total impact on supply channels which meet the DoD guidance for a logistics reliability parameter. LDs are more encompassing than ELDs, since they include all UMDs which require parts or line-replaceable units (LRU) and all scheduled maintenance demands which require parts or LRUs. ELDs also include crew correctable maintenance demands (CCMD) that use parts from the BII. It does not include preventive maintenance checks and services (PMCS) or maintenance that does not require parts.

k. Maintainability. A measure of the ability of an item to be retained in, or restored to, a specified condition when maintenance is performed by personnel having specified skill levels using prescribed procedures.

l. Maintenance Ratio (MR). A measure of the maintenance manpower required to maintain a system in an operational environment. It is expressed as the cumulative number of direct maintenance man-hours (see AR 570-2) during a given period, divided by the cumulative number of system life units (such as hours, rounds, or miles) during the same period. The MR is frequently expressed by individual maintenance level; e.g., Unit, Direct Support, and combined levels. Additionally, it may be also be stratified by scheduled and unscheduled. All maintenance actions are considered (that is, scheduled as well as corrective, and without regard to their effect on mission or availability of system). Man-hours for off-system repair of replaced components are included in the MR for the respective level.

m. Maximum Time To Repair (MaxTTR). That time below which a specified percentage of all corrective maintenance tasks must be completed. When stated as a requirement, the MaxTRR should be stated for organizational and direct support levels of maintenance. MaxTRR is used as an "on-system" maintainability parameter; it is not used for the off-system repair of replaced components.

n. Mean Time Between Essential Function Failure (MTBEFF). A measure of operational effectiveness that represents the frequency a system would be unable to fully perform any essential functions at or above specified levels.

o. Mean Time Between Essential Maintenance Actions (MTBEMA). For a particular measurement interval, the total number of system life units (hour, mile, round, etc.) divided by the total number of nondeferrable maintenance actions. This parameter indicates the frequency of demand for essential maintenance support and includes incidents caused by accidents, maintenance errors, and item abuse. (Not included are crew maintenance completed within a specified number of minutes, maintenance deferrable to the next scheduled maintenance, system modification, and test-peculiar maintenance.)

p. Mean Time Between Operational Mission Failure (MTBOMF)/Mean Time Between Mission Affecting Failure (MTBMAF). A measure of operational effectiveness that considers the inability to perform one or more mission-essential functions.

q. Mean Time Between System Abort (MTBSA). A measure of operational effectiveness that reflects the frequency a commander would remove a system from the ongoing mission and/or not begin another mission.

r. Mean Time Between Unscheduled Maintenance Actions (MTBUMA). Computed by the following formula:

$$\text{MTBUMA} = \frac{\text{Operating Time}}{\text{Total Number of Unscheduled Maintenance Actions}}$$

s. Mean Time To Repair (MTTR). The sum of corrective maintenance times divided by the total number of corrective maintenance actions during a given period of time under stated conditions. MTTR may be used to quantify the system's maintainability characteristic. MTTR applies to the system-level configuration; it will be used as an "on-system" maintainability index and not for the repair of components. MTTRs will be stated for the unit and the intermediate direct support levels of maintenance along with the percentage of all actions performed at each level.

t. Mission Reliability (Rm). A measure of operational effectiveness. It is stated in terms of a probability of completing a specified mission profile or as a function of the mean time (or distance or rounds) between critical failures.

u. Mission-Essential Functions. The minimum operational tasks that the system must be capable of performing to accomplish its mission profiles.

v. Non-Essential Unscheduled Maintenance Demand (NUMD). A NUMD results from an incident requiring unscheduled maintenance that can be deferred until the next scheduled maintenance service at the prescribed level of maintenance. NUMDs can be deferred indefinitely or until the next scheduled service without impacting the system's essential functions, causing danger to the crew, or causing potential damage to the system.

w. Off-System Maintenance. Maintenance associated with the diagnosis and repair of components for return to stock.

x. On-System Maintenance. Maintenance necessary to keep a system in, or return a system to, an operating status.

y. Operational Availability. The proportion of time a system is either operating, or is capable of operating, when used in a specific manner in a typical maintenance and supply environment. All calendar time when operating in accordance with wartime operational mode summary/mission profile (OMS/MP) is considered. The formula is as follows:

$$Ao = \frac{OT + ST}{OT + ST + TCM + TPM + TALDT}$$

$$= \frac{\text{Total Calendar Time Minus Total Downtime}}{\text{Total Calendar Time}}$$

Where:

OT = The operating time during OMS/MP

ST = Standby time (not operating, but assumed operable) during OMS/MP

TCM = The total corrective maintenance downtime in clock hours during OMS/MP

TPM = The total preventive maintenance downtime in clock hours during OMS/MP

TALDT = Total administrative and logistics downtime (caused by OMFs) spent waiting for parts, maintenance personnel, or transportation during OMS/MP. (Note that events attributed to downtime may consist of System Aborts, Mission Affecting Failures, Essential Function Failures, and Essential Maintenance Actions and are system specific dependent on that system's formally defined Failure Definition/Scoring Criteria.)

Other forms of this equation are substituted depending on the system type (see AMC/TRADOC PAM 70-11) such as the inclusion of relocation time.

z. Operational Mission Failure (OMF)/Mission Affecting Failure (MAF). Any incident or malfunction of the system that causes (or could cause) the inability to perform one or more designated mission-essential functions.

aa. Operational RAM Value. Any measure of RAM that includes the combined effects of item design, quality, installation, environment, operation, maintenance, and repair. (This measure encompasses hardware, software, crew, maintenance personnel, equipment publications, tools, TMDE, and the natural, operating, and support environments.

ab. Reliability. The probability that an item can perform its intended functions for a specified time interval under stated conditions.

ac. Reliability After Storage. This may be a stated requirement. If appropriate, it specifies the amount of deterioration acceptable during storage. Length of storage, storage environment, and surveillance constraints are identified. This requirement may not be testable; it may rely on an engineering analysis for its assessment before deployment.

ad. Scheduled Maintenance Demand (SMD). SMDs result from regularly scheduled service, as well as "on-condition" maintenance (usage, wear, etc.), such as tire or track replacement based on documented replacement criteria. Crew preventive maintenance, checks, and services (PMCS) are also considered scheduled maintenance. (PMCS is normally not considered when calculating maintenance ratios.) To qualify as an SMD, the incident must meet the necessary intervals/conditions/durability requirements as defined in the technical documentation for the system.

ae. System Abort (SA). Any incident or malfunction of the system that causes (or could have caused) the system to be removed from the ongoing mission and/or not begin another mission. All SAs are also Essential Function Failures (EFF). A SA renders the system not mission capable (NMC) under wartime definitions.

APPENDIX 2

NAVY TERMS AND DEFINITIONS

1. PURPOSE. This Appendix provides the RAM terms and used within the Navy in conducting and reporting OT&E activity in accordance with Agreement so as to assist other services in understanding RAM terms as used by the Navy.

2. SUITABILITY CALCULATIONS:

a. Reliability. The parameters for addressing reliability are mission reliability (R) and mean time between operational mission failures (MTBOMF). For aircraft, system operating time may be expressed in flight hours, resulting in the parameter mean flight hours between operational mission failures (MFHBOMF) rather than MTBOMF.

(1) R is the probability that the system will complete a mission without an operational mission hardware failure or operational mission software fault. R is recommended for systems that are operated only during a relatively short duration mission (as opposed to operating more or less continuously).

$$R = \frac{\text{Number of Missions Without an Operational Mission Hardware Failure or Software Fault}}{\text{Total Number of Missions}}$$

(2) MTBOMF is used for more or less continuously operating systems and is addressed using the following parameters:

(a) MTBOMF-Hardware ($MTBOMF_{HW}$). $MTBOMF_{HW}$ is the mean time between operational mission hardware failures occurring during system operation and is calculated as:

$$MTBOMF_{HW} = \frac{\text{Total System Operating Time}}{\text{Number of Operational Mission Hardware Failures}}$$

Where an operational mission hardware failure is one which prevents the system from performing one or more mission essential functions. System operating time includes only the time the system is operating and being stressed under operational loads. It does not include standby time. For aircraft, system operating time is from the attempt to start the aircraft with the intent to perform a mission until engine shutdown.

(b) MTBOMF-Software ($MTBOMF_{SW}$). $MTBOMF_{SW}$ is the mean time between operational mission software faults. A software fault is any interruption of system operation not directly attributable to hardware, and is calculated as:

$$\text{MTBOMF}_{SW} = \frac{\text{Total System Operating Time}}{\text{Number of Operational Mission Software Faults}}$$

(c) MTBOMF-System (MTBOMF_{SYS}). MTBOMF_{SYS} is the mean time between operational mission hardware failures and operational mission software faults which occur during system operation and is calculated as:

$$\text{MTBOMF}_{SYS} = \frac{\text{Total System Operating Time}}{\text{Total Number of Operational Mission Hardware Failures / Software Faults}}$$

As a general rule, MTBOMF_{SYS} should not be used as a test measure when MTBOMF_{HW} and/or MTBOMF_{SW} can be used instead.

(d) Mission Completion Rate (MCR). MCR is for multimission systems with short mission duration (whole aircraft), and is calculated as:

$$\text{MCR} = \frac{\text{Number of Missions Successfully Completed}}{\text{Number of Missions Attempted}}$$

A mission is not successfully completed when it is aborted due to the occurrence of a system failure that precludes the system from performing the assigned mission. The number of missions attempted includes only those missions in which factors beyond the design control of the system, such as range delays or asset nonavailability, do not impede the successful completion of the mission.

MCR may be used in addition to other reliability measures. MCR may be used alone if necessary but should not be used to replace other reliability measures.

(e) MTBUM/MFHBUM**.** These are measures of the time (flight hours) between unscheduled maintenance actions (may or may not be hardware failure related) compared to total operating time.

$$\text{MTBUM / MFHBUM} = \frac{\text{Total System Operating Hours (Flight Hours)}}{\text{Number of Unscheduled Maintenance Actions}}$$

MTBUM/MFHBUM will be thresholded and reported on a case-by-case basis.

b. Maintainability. The parameters for addressing maintainability are mean corrective maintenance time for operational mission failures (MCMTOMF), maximum corrective

maintenance time for operational mission failures (MaxCMTOMF), mean corrective maintenance time for operational mission faults-software ($MCMTOMF_{SW}$), mean reboot time (MRT), built-in test (BIT), and maintenance ratio (MR).

(1) MCMTOMF is the average elapsed corrective maintenance time needed to repair all operational mission hardware failures. It includes time for maintenance preparation, fault location and isolation, on-board parts procurement, fault correction, adjustment and calibration, as well as follow-up checkout time. It does not include off-board logistic delay time.

$$MCMTOMF = \frac{\text{Total Elapsed Time to Correct Operational Mission Failures}}{\text{Total Number of Operational Mission Failures}}$$

On-board logistic delay is the logistic delay associated with obtaining the spare part at the unit or organizational level. For aircraft systems, the unit level will be considered to be the squadron. Therefore; MCMTOMF will be calculated as the mean of the elapsed maintenance time (block A45 of the maintenance action form).

(2) MaxCMTOMF is that time below which a specified percentage of corrective maintenance tasks must be completed to restore the system to operation after an operational mission failure (OMF); e.g., 90% of all corrective maintenance times for operational mission hardware repairs will be less than MaxCMTOMF. This parameter is recommended when the time required to repair and restore the system due to operational urgency is considered an important aspect of the system under test.

(3) $MCMTOMF_{SW}$ is the average elapsed time needed to restore a software-intensive system following an operational mission software fault. The system is considered to be restored when a tactical picture that is useful to the tactical action officer/operator is first established. This may include the time to restore all processes, functions, files, and databases to a tactically useful state as well as the time required to physically reboot the system following an operational mission software fault.

It does not include the time to obtain spare parts or utilize the expertise of personnel outside the unit or organizational level. For aircraft systems, the unit level will be the squadron.

$$\text{MCMTOMFsw} = \frac{\text{Total Elapsed Time to Restore Software - Intensive Systems After an Operational Mission Software Fault}}{\text{Total Number of Operational Mission Software Faults}}$$

(4) MRT is the average elapsed time required to reboot a software-intensive system. MRT is addressed as cold start MRT (MRT_C) and warm start MRT (MRT_W). Both MRT_C and MRT_W include only the time necessary to physically reboot the system, not the time required for restoration of the tactical picture as in $MCMTOMF_{SW}$.

$$\text{MRT} = \frac{\text{Total Elapsed Time to Reboot a Software - Intensive System}}{\text{Total Number of Software Reboots}}$$

(5) BIT is addressed using these parameters: probability of correct detection (Pcd); probability of correct fault isolation (Pcfi); and probability of a false alarm (FA). It is recommended that all three equations be used together to ensure a complete picture of BIT performance.

(a) Pcd is a measure of BIT's capability to detect failures/faults and is calculated as:

$$\text{Pcd} = \frac{\text{Number of Failures / Faults Correctly Detected by BIT}}{\text{Number of Actual System Failures / Faults}}$$

(b) Pcfi is a measure of BIT's capability to isolate the failure to a specified replaceable assembly and is calculated as:

$$\text{Pcfi} = \frac{\text{Number of Failures Correctly Isolated}}{\text{Total Number of Failures Correctly Detected by BIT}}$$

(c) FA is the measure of BIT indicating a failure when none has occurred and is calculated as:

$$\text{FA} = \frac{\text{Number of Incorrect BIT Failure Indications}}{\text{Total Number of BIT Failure Indications}}$$

For aircraft, you may also calculate the number of false BIT indications per system operating hour (FAh).

$$FAh = \frac{\text{Number of Incorrect BIT Failure Indications}}{\text{Total Number of Operating Hours}}$$

(d) MR is a measure of the ratio of total maintenance man-hours required to perform required preventive maintenance and repair all hardware failures to operating/flight hours and is calculated as:

$$MR = \frac{\text{Total Maintenance Man-Hours to Accomplish Required Preventive Maintenance and Repair all Failures}}{\text{Total System Operating / Flight Hours}}$$

c. Availability. The parameter for addressing operational availability is A_O.

(a) For continuously operating systems, A_O is calculated as:

$$A_O = \frac{\text{Uptime}}{\text{Uptime} + \text{Downtime}}$$

where uptime is that time when the system is considered to be ready for use and is either operating, in standby, or off. Downtime is the time the system is down for repair of operational mission hardware failures and/or for restoration from operational mission software faults, including off-board logistic delays. It also includes planned maintenance time with a periodicity less than or equal to the test duration time that prevents the system from performing its assigned mission. Planned maintenance time that is of periodicity greater than the test duration time is considered neutral time and is not included in the availability calculation.

(b) For on-demand systems, A_O is calculated as:

$$A_O = \frac{\text{Number of Times System was Available}}{\text{Number of Times System was Required}}$$

where the number of times the system was required shall include the number of times it was operationally required but not used because the system was known to be inoperable.

(c) For multimission systems (i.e., whole aircraft, ships, or submarines) the measures of availability are full mission capable (FMC), partial mission capable (PMC), and mission capability by mission area (MC_{MA}).

(1) FMC is defined as the material condition of a system in which it can perform all of its missions. FMC is calculated as:

$$FMC = \frac{\text{Uptime}}{\text{Uptime} + \text{Downtime}}$$

where uptime is the time the test system is capable of performing all its missions as defined by the MC_{MA} mission areas.

(2) PMC is defined as the material condition of a system in which it can perform at least one of its missions. PMC is calculated as:

$$PMC = \frac{\text{Uptime}}{\text{Uptime} + \text{Downtime}}$$

where uptime is the time the system is capable of performing at least one of its missions as defined by the MC_{MA} mission areas.

(3) MC_{MA} is a measure of the system's capability to perform a specified mission and is calculated as:

$$MC_{MA} = \frac{\text{Uptime}}{\text{Uptime} + \text{Downtime}}$$

where uptime is the time the test system is capable of performing a specified mission. For aircraft, mission areas will be determined from the aircraft type Mission Essential Subsystem Matrices (MESM) in accordance with OPNAVINST 5442.4 series, as supplemented by operational experience.

No Mission Capability (NMC) would be a measure of the proportion of time during which a system can perform none of its missions. Since NMC is the complement of PMC (i.e., NMC=1-PMC), there is no need to use NMC. When calculating FMC and PMC it may be useful to refer to 'not mission capable time', which would be equivalent to PMC downtime. But, take care not to confuse terms for the measures with terms for system states or time accounting.

APPENDIX 3

MARINE CORPS TERMS AND DEFINITIONS

1. Purpose. This Appendix provides RAM definitions and quantitative MOEs for USMC OT plans and reports.

2. Background. Effective testing and evaluation of a system can only be accomplished if all system peculiar terms and MOEs are defined and understood during the test design. Definitions and the selection of MOEs cannot be changed subsequent to the start of a test without running the risk of either invalidating the data already collected or biasing the subsequent data collection effort and analysis. Every IER should interpret the MOEs to present a meaningful picture of the impact of the evaluation to the decision makers.

It is MCOTEA policy to test against RAM requirements contained in the approved, validated ORD. When these ORD-based requirements differ from those defined and contained in this Appendix, those ORD-based requirements will be tested against, and the adequacy of demonstrated performance will be resolved against the ORD-based thresholds. However, to support comparability and the intent of this Appendix, in MOT&E MCOTEA will also measure and report the related RAM terms contained in this Appendix, although the reported values will not be used for resolution of RAM criteria.

3. Definitions. Definitions are organized into five sections: time, status, reliability, availability, and maintainability. Within each category, terms and MOEs are listed and defined. Note that while the acronyms and equations used are not consistent with notations in the 1982 DoD RAM Primer, they are computationally consistent. For example, mission time as defined here is computationally equivalent to the operating time defined in the RAM Primer. The terms item and system are used interchangeably throughout.

a. Time. Time that elapses during a test can be measured and classified in many ways. Figure 3-1 illustrates the time relationships within a test. Table 3-1 is a legend for Figure 3-1. Note that some time classifications may not apply to a specific system. Boxes within the figure are mutually exclusive. Figure 3-1 shown on page A3-2.

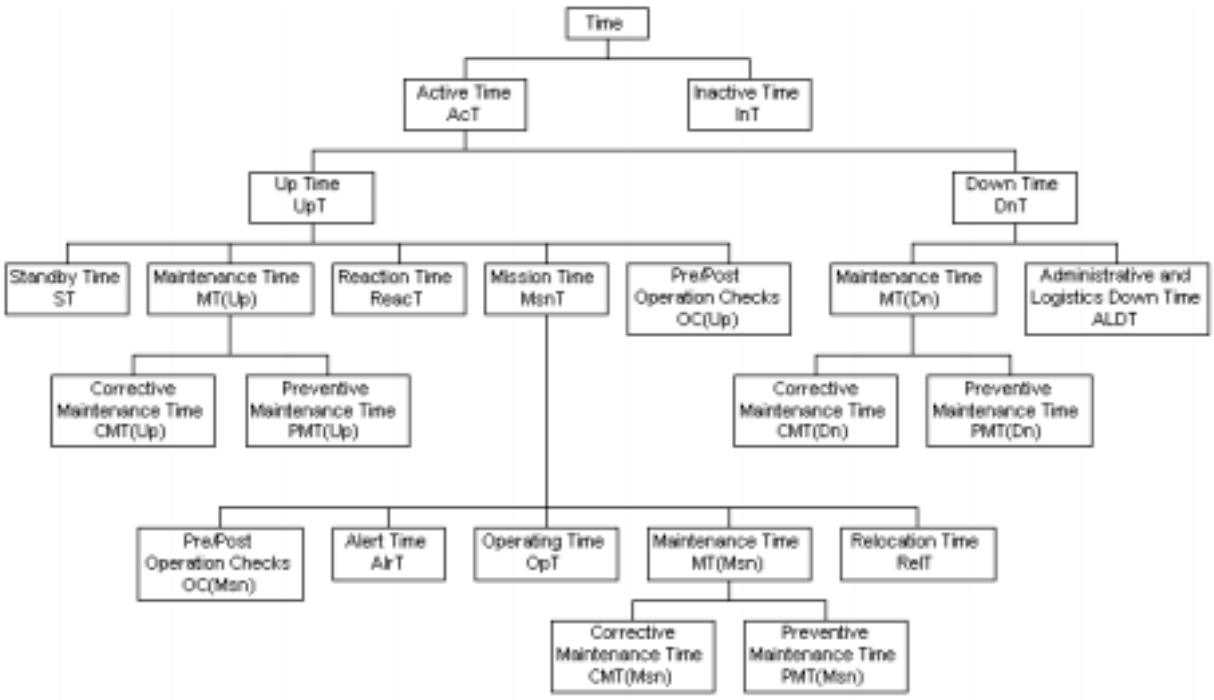

Figure 3-1. Test Time Classifications

Table 3-1. Test Time Classifications

• Active Time (AcT). Consists of all time when the system under test is assigned to an operational unit, and is being used consistent with its Concept of Employment. During AcT, the system under test is being used to accomplish its intended missions and Operational Test data should be collected. The most important aspect of AcT is that it only occurs when the system under test is being used, as it is expected to be used, when fielded in the realistic operational environment. Thus, time accruing due to test artificiality's, not representative of realistic use, must be excluded from AcT.
• Administrative and Logistics Down Time (ALDT). The portion of downtime when active corrective maintenance is not being performed that includes (but is not limited to) time waiting for parts, processing records, and transporting equipment and/or maintenance personnel between the using unit and repair facility.
• Alert Time (AlrT). Mission time (up time) when an item is required to be in a specified operating condition and is awaiting a command to perform its intended mission. Alert time occurs when a system is employed on a specific mission profile but is not actually operating. The system is awaiting the command to continue its specific mission. This may apply to systems with a "Standby" mode.

Table 3-1. Test Time Classifications (cont.)

- Corrective Maintenance Time (CMT). Time when maintenance is performed on a scheduled or nonscheduled basis to restore system functions by actively troubleshooting, performing system diagnostics, or correcting a malfunction. Corrective Maintenance can occur during up time, down time, and mission time.
- Down Time (DnT). Active time when the system cannot perform one or more Mission Essential Functions (mefs).
- Inactive Time (InT). Consists of time when the system under test is either not assigned to an operational test unit, or, while assigned, is not being used consistent with its Concept of Employment. During InT, the system under test is not being used to accomplish its intended missions, and reportable OT data will not be collected. Typically, InT is time when the system under test is not being used as it would be, when fielded, in a realistic operational environment. Once OT begins, InT should largely consist of unrealistic lulls in activity due to planned schedule breaks, such as weekends, etc. Note that, during InT, no actions can be taken that alters the system under test in any way. For example, no maintenance, preventive or corrective, related to any previous AcT time segments can be conducted.
- Maintenance Time (MT). Time when preventative or corrective maintenance is being performed on the system. Maintenance time can occur during up time, down time or mission time.
- Mission Time (MsnT). Up time when the system is required to perform its mission profile as stated in the COE or the Operational Mode Summary/Mission Profile (OMS/MP).
- Operating Time (OpT). The period of time that the system is powered, capable of performing all mefs, and required to perform within its stated mission profile.
- Pre/Post Operation Checks (OC). Time when checks are routinely accomplished prior to and just after operating a system. These checks can occur outside or during mission time.
- Preventative Maintenance Time (PMT). Time when preventative maintenance actions are performed to retain an item in a specified condition by systematic inspection, detection, and prevention of incipient failures. These actions can occur during up time, down time, or mission time, on a scheduled or unscheduled basis.
- Reaction Time (ReacT). Portion of up time that starts with receipt of the mission and ends with initiation of the mission.
- Relocation Time (RelT). Mission time when the item is moved from one location to another where it is employed on a specific mission profile.
- Standby Time (ST). The period of up time that the system is presumed operationally ready for use, but it does not have power applied if applicable, is not being operationally employed, and maintenance is not being performed.
- Up Time (UpT). Active time when an item is able to perform all mefs.

b. Status. Three general questions must be answered to determine the general status of an item (active/inactive, up/down, mission/other). Specific determinations of status within general categories are system dependent and must be defined in the DTP. The questions follow.

(1) Is the system assigned to an operational unit which is using the system consistent with its COE, to accomplish the missions for which it was designed, in the realistic operational environment? (Note: Items evacuated for maintenance remain assigned to the operational unit.)

Yes - active
No - Inactive

(2) Can the item perform all of its mefs?

Yes - up
No - down

(3) Is the item being required to perform its intended function in accordance with its mission profile?

Yes - mission
No - other

c. Reliability. Reliability consists of two major areas: mission reliability and logistics related reliability.

(1) Mission Reliability. Mission reliability is the probability the system will perform mefs for a period of time under the conditions stated in the mission profile. Mission reliability can also be stated as the probability a system can complete its required operational mission without an Operational Mission Failure (OMF). An OMF is a failure that prevents the system from performing one or more mefs. Two measures of mission reliability are mean time between operational mission failure and item reliability.

Mean Time Between Operational Mission Failure (MTBOMF). MTBOMF is the average amount of operating time between OMFs. Alternatively, time can be replaced with cycles, rounds, miles, etc. (i.e., MCBOMF, MRBOMF, MMBOMF, etc.), as appropriate for the system under test. A subscript of "c" indicates that only OMFs charged to CFE are used in the calculation.

$$MTBOMF = \frac{MsnT}{Total\ Number\ of\ OMFs}$$

Item Reliability (R). Item reliability is the probability that an item will perform its intended function for a specified interval under stated conditions. Generally this is the probability that an item will perform its mefs for its specified Mission Duration (MD) under conditions corresponding to its mission profile as stated in the COE or OMS/MP. MD is the length of a mission as defined in the mission profile. All OMFs, regardless of chargeability, are used in the calculations. Depending upon the nature of the item, either a discrete or continuous

reliability model will be used. Generally, the distribution of failure can be assumed to be binomial for discrete items, and exponential for continuous items. Other failure distributions may be used when appropriate. See paragraph 6540 for a discussion of alternative continuous distribution reliability models.

Discrete Model. Based on the binomial distribution:

$$R = \frac{Number\ of\ Successful\ Missions}{Total\ Number\ of\ Missions\ Attempted}$$

Continuous Model. Based on the exponential distribution:

$$R = 1 - F(MD) = e^{\left(\frac{-MD}{MTBOMF}\right)}$$

(2) Logistics Related Reliability. The probability that no corrective (or unscheduled) maintenance, unscheduled removals, and/or unscheduled demands for spare parts will occur following the completion of a specific mission profile.

Mean Time Between Unscheduled Maintenance (MTBUM). Average time between unscheduled maintenance actions:

$$MTBUM = \frac{MsnT}{Number\ of\ Incidents\ Requiring\ Unscheduled\ Maintenance}$$

d. Availability. Availability is the probability that a system is operable and committable at the start of a mission when the mission is called for at a random point in time. There are three measures of availability: operational availability, inherent availability, and achieved availability.

(1) Operational Availability (A_o). A_o is availability during all segments of time when the equipment is intended to be operational. A_o provides the most realistic measure of availability of equipment deployed and functioning in a combat environment. However, one significant problem associated with determining A_o is the calculation of ALDT and PMT. Defining ALDT and PMT under combat conditions is not feasible in most instances and data collected during a test may not provide a good estimate. Either the discrete model (for on-demand equipment) or the continuous model of operational availability may be used, as appropriate.

Discrete Model. Based on the binomial distribution:

$$A_o = \frac{Number\ of\ Times\ the\ System\ is\ Available}{Number\ of\ Times\ the\ System\ is\ Required}$$

Continuous Model. Based on the exponential distribution:

$$A_o = \frac{UpT}{UpT + DnT}$$

Where UpT and DnT are determined by totaling their subcomponent times (Refer to Figure 3-1).

(2) Inherent Availability (A_i). A_i is availability, only with respect to operating time and corrective maintenance. A_i is useful in determining basic operational characteristics under conditions that might include testing in a contractor's facility or other controlled facility. A_i provides a very poor estimate of true combat potential for most systems, because it provides no indication of the time required to obtain necessary field support. This measure should normally not be used to support an operational test.

$$A_i = \frac{OpT}{OpT + CMT(Dn)}$$

(3) Achieved Availability (A_a). A_a is a hardware-oriented measure primarily used during developmental testing and initial production testing when the system is not operating in its intended support environment. Excluded are operator maintenance checks, standby, and ALDT.

$$A_a = \frac{OpT}{OpT + MT(Dn)}$$

e. Maintainability. The ability of an item to be retained in or restored to specified condition when maintenance is performed by personnel having specified skill levels, using prescribed procedures and resources, at each prescribed level of maintenance and repair. Maintainability consists of two major categories: maintenance and diagnostics.

(1) Maintenance

Levels of Maintenance. Marine Corps doctrinal maintenance levels may be used to categorize thresholds for maintainability MOEs. Table 3-2 includes the three levels of maintenance that may be used. Table 3-2 shown on page A3-7.

Table 3-2. Doctrinal Levels of Maintenance

• Preventative Maintenance (PM). Specified maintenance actions to retain an item in a specified condition by systematic inspection, detection, and prevention of incipient failures (i.e., before, during, and after and at halt checks and other similar actions requiring only first echelon maintenance)"
• Organizational Level Maintenance (OLM). OLM is authorized maintenance performed by the responsible using organization, on its own equipment. OLM consists of 1st and 2nd echelon maintenance.
• Intermediate Level Maintenance (ILM). Maintenance that is authorized by designated maintenance activities in support of using organizations. The principal function of ILM is to repair subassemblies, assemblies and major items of equipment for return to a lower echelon or to supply channels. ILM consists of 3rd and 4th echelon maintenance.
• Depot Level Maintenance (DLM). Maintenance that is performed by designated industrial-type activities using production-line techniques programs and schedules. The principal function is to overhaul or completely rebuild parts. DLM is equivalent to 5th echelon maintenance.

Mean Corrective Maintenance Time (MCMT). MCMT is the average of active corrective maintenance times. This replaces the obsolete term Mean Time to Repair (MTTR). The time is clock time vice man-hours. Notations following the MTTR indicate maintenance levels: (O) for organizational, (I) for intermediate, or (D) for depot level.

$$MCMT = \frac{CMT}{Total\ Number\ of\ CM\ Actions}$$

Maximum Corrective Maintenance Time (MaxCMT). MaxCMT is time below a specified percentage of all corrective maintenance tasks are completed. MaxCMT replaces the obsolete term Maximum Time to Repair (MaxTTR). The time is clock time vice man-hours. Three types of qualifiers to MaxCMT are identified in Table 3-3.

Table 3-3. Three Qualifiers to MaxCMT

• Percentile. As a subscript between the "Max" and "CMT," a percentile may be specified. Example, $Max_{90}CMT$ indicates the 90th percentile CM period.
• Type of CM. Without a subscript, "MaxCMT" refers to all CM intervals. Example, "MaxCMT(Dn)" refers to CMT(Dn) intervals.
• Level of Maintenance. Indicated by letters in parentheses after CMT. MaxCMT(O) refers only to organizational level maintenance, while MaxCMT(I) refers to intermediate and MaxCMT(D) refers to depot level maintenance.

Maintenance Ratio (MR). Total man-hours of maintenance, per mission hour, including times for both preventive and corrective maintenance regardless of whether the system is up or down.

$$MR = \frac{Total\ Man\text{–}hours\ of\ Maintenance}{MsnT}$$

Mean Restore Function Time (MRFT). The average of all restore function intervals. That is, the average interval between when a system or component computer begins to reboot (re-initialize) and when all its mefs are restored. This replaces the obsolete metric Mean Time to Restore Function (MTTRF). All intervals are elapsed clock times. Without a subscript, MRFT refers to the average of all restore function intervals. MRFT(Up) is the average of all restore function-equipment up intervals, while MRFT(Dn) is the average of all restore function-equipment down intervals.

(2) Diagnostics

False Alarms (FA). False alarms are faults where, upon investigation, the fault cannot be confirmed. Measures of FA may be expressed as a total number, a percentage, a rate of occurrence, a probability of occurrence, etc. The selected measure must be clearly stated in the ORD and DTP.

Mean Time to Fault Locate (MTTFL). Average time to fault locate:

$$MTTFL = \frac{Total\ Time\ to\ Fault\ Locate}{Total\ Number\ of\ Faults}$$

Percent of Correct Detection (Pcd). Given that a fault has occurred, the proportion of faults correctly detected:

$$Pcd = \frac{Number\ of\ Correct\ Detections}{Total\ Number\ of\ Confirmed\ Faults} \times 100\%$$

Percent of Correct Fault Isolation (Pcfi). Given a correct detection, the proportion of correct fault isolations (and/or fault locations). "Fault isolation" and/or "fault location" must be clearly defined in the ORD and DTP.

$$Pcfi = \frac{Number\ of\ Correct\ Fault\ Isolations\ and/or\ Locations}{Number\ of\ Correct\ Detections} \times 100\%$$

APPENDIX 4

AIR FORCE TERMS AND DEFINITIONS

1. Purpose. This Appendix provides the RAM terms and definitions that are most relevant to this Annex and used within the Air Force in conducting and reporting OT&E activity. They have been adapted from AFI 10-602, 20 June 1994. In addition to hardware considerations, MAJCOMs must consider software design and supportability measures when describing top-level logistics requirements for weapon system and support systems software (AFI 10-602). They are included in the Memorandum of Agreement so as to assist other services in understanding RAM terms as used by the Air Force.

2. Definitions

a. Break Rate: The percent of time an aircraft will return from an assigned mission with one or more previously working system or subsystems on the Mission-Essential Subsystem List (MESL) inoperable (code 3 including ground and air aborts). Repairs must be made before the aircraft can perform a subsequent "like-type" mission.

b. Fix Rate: The percent of aircraft, which return "code 3" from an assigned mission, that must be repaired in a specified number of clock-hours, i.e., 70 percent in 4 hours. Fix rate is similar to mean downtime. The time requirement for fix rate includes direct maintenance time and down time associated with maintenance policy and administrative and logistics delays.

c. Logistics Reliability: Logistics reliability is a measure of the system's frequency of maintenance under defined operational and support concepts, using specific logistics resources. A measure of logistics reliability is Mean Time Between Maintenance (MTBM). It is the average time between all maintenance events, that is, both scheduled and unscheduled events. MTBM is defined as follows:

$$\text{MTBM} = \frac{\text{Number of operating hours}}{\text{Number of maintenance events}}$$

d. Maintainability: The ability of an item to be retained in or restored to a specified condition when maintenance is performed by personnel having specified skill levels, using prescribed procedures and resources, at each prescribed level of maintenance and repair.

e. Maintainability Man-Hours/Operating Hour (MMH/OH): The number of base level, direct maintenance man-hours required to support a system divided by the number of operating hours during the period. Where aircraft, ships, and vans are involved, maintenance man-hours/flying hours (MMH/FH), maintenance man-hours/sortie (MMH/S), or some similar requirement may be used.

f. Maximum Time To Repair (MaxTTR): The time within which a specified percentage of all corrective maintenance tasks must be completed. For example, 90 percent of all corrective maintenance actions must be completed within two hours.

g. Mean Time to Restore Function (MTTRF): The average time required, as the result of a critical failure, to restore a system to full operating status. It includes administrative and logistics delay times associated with restoring function following a critical failure. MTTRF is defined as:

$$\text{MTTRF} = \frac{\text{Total critical restore time}}{\text{Number of critical failures}}$$

h. Mean Time Between Downing Event (MTBDE): The average time between events that bring a system down. Downtime can include critical or non-critical failures, preventative maintenance, training, maintenance and supply response, administrative delays and actual equipment repair. Besides the inherent repair and maintainability characteristics, field conditions such as tech-order availability and adequacy, support equipment capability and availability, supply levels, manning, experience level and shift structure also affect down times. MTBDE is defined as:

$$\text{MTBDE} = \frac{\text{Number of operating hours}}{\text{Number of downing events}}$$

i. Mean Repair Time (MRT): The average on-equipment, off-equipment or both corrective maintenance times. It includes all maintenance actions needed to correct a malfunction, including preparing for test, troubleshooting, removing and replacing components, repairing, adjusting, re-assembly, alignment, adjustment, and checkout. MRT does not include maintenance or supply delays. MRT does not include maintenance, supply or administrative delays. MRT is defined as:

$$\text{MRT} = \frac{\text{Number of corrective repair hours}}{\text{Number of corrective maintenance events}}$$

NOTE: MRT differs from the contractual term Mean Time To Repair (MTTR) in that it measures maintenance activities that occur in the operational environment.

j. Mean Downtime (MDT): The average elapsed clock-time between loss of mission-capable status and restoration of the system to mission-capable status. This downtime includes maintenance and supply response, administrative delays, and actual on-equipment repair. In addition to the inherent repair and maintainability characteristics, mean downtime is affected by technical order availability and adequacy, support equipment capability and availability supply levels, and manning. Thus, MDT is not the same as the contractual term mean time to repair (MTTR).

k. Mean Time Between Critical Failures (MTBCF): The average time between failure of mission-essential system functions. Critical failures do not have to occur during a mission, they merely must or could cause mission impact. MTBCF is defined as:

$$\text{MTBCF} = \frac{\text{Number of operating hours}}{\text{Number of critical failures}}$$

l. Mean Time Between Maintenance Events (MTBME): The average time between on-equipment, corrective events including inherent, induced, no-defect, and preventive maintenance actions. It is computed by dividing the total number of life units (for example, operating hours, flight hours, rounds) by the total number of maintenance (base level) events for a specific period of time. A maintenance event is composed of one or more maintenance actions.

m. Mean Time Between Removal (MTBR): A measure of the system reliability parameter related to demand for logistic support. The total number of system life units divided by the total number of items removed from that system during a stated period of time. This term is defined to exclude removals performed to facilitate other maintenance and removals for time compliance technical orders (TCTOs).

n. Mission-Capable (MC) Rate: The percent of possessed time that a weapons system is capable of performing any of its assigned missions. The MC rate is the sum of the full mission-capable (FMC) and partial mission-capable (PMC) rates.

o. Mission Reliability (MR): The probability that the system is operable and capable of performing its required function for a stated mission duration or at a specified time into the mission. MR is based on the effects of system reliability during mission time only. MR does not take into account system maintainability. For systems with exponential failures, MR is defined as follows:

$$\text{MR} = e^{(-t / \text{MTBCF})}$$

where t is the average mission time. If the system is used under significantly different mission lengths, the specific mission time should be used to determine the MR for each mission. Note: Exponential systems are systems whose times to failure exhibit an exponential probability density function (i.e., systems that exhibit a constant hazard rate).

p. Operational Availability: The probability that a system can be used for any specified purpose when desired. It includes both the inherent reliability and maintainability parameters and logistics support effectiveness of the system that relates to the total time the system might be desired for use. A_o is defined as follows:

$$A_o = \frac{\text{Uptime}}{\text{Total Time}}$$

which is equivalent to:

$$A_o = \frac{MTBDE}{MTBDE + MDT}$$

q. Operational Dependability (Do): The probability a system can be used to perform a specified mission when desired. It includes both the inherent reliability and maintainability parameters and logistics support effectiveness of the system that relates to all time the system might be desired for mission use and for which critical failures could occur. It can be expressed in terms of the Mean Time Between Critical Failure (MTCBF) and Mean Time to Restore Functions (MTTRF).

$$D_O = \frac{MTBCF}{MTBCF + MTTRF}$$

r. Percent of faults that terminate in a CND: Measures the volume burden to O-level maintenance contributed by fault isolations (FI) that terminate in a CND. It is computed with the following formula:

$$\% \text{ CND} = \frac{\text{Number of O-level FIs that terminate in a CND}}{\text{Number of O-level troubleshooting actions}} \text{ X } 100$$

*Excludes false alarms that do not generate maintenance actions.

s. Percent BIT Fault Detection (FD): Measures instances where a maintenance request was initiated when equipment performance (including BIT performance) is less than that required to perform a satisfactory mission, and corrective action is required to restore equipment performance. The formula below assumes that a requirement exists for 100-percent diagnostics capability.

$$\% \text{ BIT FD} = \frac{\text{Number of failures detected by BIT that result in an O-level troubleshooting action}}{\text{Number of O-level troubleshooting actions detected via all methods}} \text{ X } 100$$

t. Percent Fault Isolation (FI): It is just as operationally valuable for BIT to fault-isolate an aircrew- reported fault, or manually detected fault, as it is for BIT to fault-isolate BIT-detected faults. Effective isolation means that the fault is unambiguously isolated to a single-item node (driver, receiver, connector, wire) or to a specified maximum number of items (an ambiguity group of x items). The formula below defines the percent of FI.

$$\% \text{ FI} = \frac{\text{Number of fault isolations in which BIT effectively contributed}}{\text{Number of confirmed failures detected via all methods}} \times 100$$

u. Percent Retest OK (RTOK): Defined by the formula below as follows:

$$\% \text{ RTOK} = \frac{\text{Number of units (LRU, STU) that RTOK at a higher maintenance level}}{\text{Number of units tested at a higher maintenance level}} \times 100$$

v. Uptime Ratio (UTR): The percentage of time that operational equipment is able to satisfy mission demands. UTR is similar to MC, except that system status depends on current use of the system, as well as the designated operational capability (DOC). For example, a system with several DOC missions can be MC if at least one of those missions can be accomplished. However, if an immediate need exists for a mission capability that is "down", the overall system is considered to be "down."

w. Weapon System Reliability (WSR): The probability that a system will complete a specified mission given that the system was initially capable of doing so.

x. Unconfirmed Faults per Life Unit (UF/LU): Measures the frequency of unconfirmed faults as a function of the system's life. Unconfirmed Faults consist of False Alarms (FA) and Can-Not-Duplicates (CND). Life Unit refers to any meaningful life unit (operating hours, flight hours, sorties, etc.) for the system. It is computed by the following formula*:

$$\text{UF/LU} = \frac{\text{Number of Unconfirmed Faults (FAs and CNDs)}}{\text{Life Unit (operating hours, sorties, etc.)}}$$

*Formula may be referenced as FA/LU if only FAs are used. Similarly, if only CNDs are used, the formula may be referenced as CND/LU.

y. Mean Time to Troubleshoot (MTTT): A measure of diagnostics related to the average time needed to perform on-equipment (O-level) troubleshooting actions. It is computed by the following formula*:

$$\text{MTTT} = \frac{\text{Total O-level troubleshooting time}}{\text{Number of O-level troubleshooting actions}}$$

*Formula may be tailored by type of diagnostics method, type of fault, and/or level of maintenance.